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ELECTRO MAGNETISM AS A MOTIVE POWER.

The great notoriety to which this subject has attained, demands that it should receive from scientific men, more attention than hitherto. Since the first successful experiments in Electro Magnetic motion, innumerable attempts have been made to produce engines acting under this agent—the plans of these have been as various as their sizes, which are from that of a mere philosophical toy, up to one said to be of one or two horse power. The various merits of these, we by no means intend to discuss, because in the first place, the elements of a proper comparison are not given, and not to be found, and in the second place, the institution of such a comparison would draw upon us the full power of the *batteries* of the various patentees and their partizans, an encounter which, whatever might be our disposition, we have no time for just now. Perhaps some day or other, we may get up a *battery* of our own, then, of course, we cannot decline the contest.

Our object at present is, rather to point out in general terms, what has been accomplished and what may be done towards the perfection of this kind of machinery, with reference to the probable extent of power attainable by such perfection.

The various models and engines hitherto constructed, have been nearly all upon the principle of producing a rotary motion by the alternate attraction and repulsion of moveable electro magnets with changeable poles, by fixed electro magnets with poles unchanged. More recently, this form has been exchanged for one in which revolving soft iron armatures are successively attracted by fixed electro magnets, without change of poles and through which the current is passed just before coming to the iron to be attracted, and ceases when it is reached. Another variation is, in the alternate attraction of armatures on each end of a beam, by electro magnets through which the current is alternately passed—producing a reciprocating, instead of a rotary motion.

The batteries used for these engines or models, with few exceptions have been of the common form of concentric cylinders of zinc and copper alternately placed, and excited by a dilute sulphuric acid, sulphuric and nitric acid, or a solution of sulphate of copper. The necessity of occasionally exposing this battery to the air, induced us to suggest to the inventor of the first electro magnectic engine we ever saw, the plan of forming the zinc and copper into circular plates mounted upon an axis, upon which they might be turned by hand, or better by the machine itself, and with rather less than a semicircle immersed, a constant renewal might be effected. This plan we recently saw put into operation, but of the advantage gained by it, no estimate appears to have been made. A patent for a similar battery has, we believe, been taken out. Another modification of this would be, to pass the axis through the system of concentric cylinders generally in use, placed horizontally,

Of the relative power of the various engines already constructed, nothing certain can be said. From inspection, it would appear that while some have been built with the greatest care in the mechanical arrangement, others appear to have been put together in the most inappropriate manner, not only applying the power injudiciously but losing much of the power so applied, in the enormous friction of complicated parts. As to the knowledge of the science of electro magnetism displayed in these various constructions, while in some, we have to admire its amount and application, in others we in vain look for any thing of the kind. Even some persons who have been rather successful in their first attempts have retrograded in their succeeding ones. The reason of this, apart from the general ignorance of the science is the want of a correct knowledge of the power already obtained. The simple method of ascertaining this by the time through which a given weight may be raised through a given space; has seldom if ever been tried, or if it has been tried, its results have not been made known. Now all this is but working in the dark—few machines are more easily adapted to this simple test, and why should we not have the benefit of its application? How can an inventor know with certainty, whether he is advancing or not in the form of this machine, unless he knows how much each machine can do? Simple as this mode of trial is, it has not been adopted as the test of power, as it most undoubtedly should be, and *must* be, to satisfy the judicious and prudent. This means of estimating the power, and the simple process of ascertaining the loss in weight of the battery,* and consequently the cost, furnishes us with the value of the power in each machine. For example, a machine is ascertained to raise through one foot, in one minute 33,000 pounds or a weight equal to that raised by one horse power. The battery is to be carefully washed, dried and weighed before and after the experiment, the loss indicates the quantity of zinc consumed, and this being a correct representation of the *relative* cost in each machine, we can at once estimate their comparative advanta-

* In this experiment, dilute sulphuric acid should be employed.

ges. When it is desired to ascertain the absolute expense, we add two-thirds to the weight of the zinc for the weight of the commercial sulphuric acid, and then can readily calculate the expense of the materials.

Provided with this means of ascertaining the precise value of each form of machine, we would propose the investigation of the capabilities for improvement in the following manner. All other things remaining the same, increase the size of the battery until the power gained is a maximum. The size of the battery remaining the same, vary the quantity of acid in the charge until the greatest effect is produced. The battery and its charge being retained in the most advantageous condition, increase the *size of the conductors.* We are inclined to think that a few trials would lead to this result; that the greatest power, at least cost, would be obtained by using very large batteries, excited by a slightly acidulated liquid or even by ordinary sea water, and connected to the engine by conductors of large size, or diameter. We have had occasion to remark the benefit of large conductors, in using a model moved by the influence of the earth's magnetism. It had been found impossible to cause the machine (which was not very skilfully made) to move by any increase of acid in the exciting fluid, when having applied unusually large conductors the motion immediately commenced, though the battery was not highly excited—a result precisely such as might have been predicted from a knowledge of the principles of the science.

It may be objected to these and the other trials which we may suggest, that they are tedious and costly. They certainly are somewhat so—yet, unless anticipated by a higher degree of knowledge than has generally been applied to the construction of this machine, they are absolutely necessary to its progress.

It will be found that a certain size of coating wire will give a maximum for each size of magnet and of battery. It is not improbable that a change in the size of the armature may likewise be attended by an increase in power.

We have then, the power of increasing the effect of the machine in five different ways without in the slightest degree altering its principle of construction or even its form. A gain of at least 50 per cent, might in this manner be obtained, over the present power, in most forms of electro magnetic engine.

It would in the next place, be desirable to ascertain the effect of an increased number of armatures and of magnets, and also, the most advantageous disposition of them. It is in this, that the great difficulty of increasing the power of the machine lies, and here the greatest skill is necessary in the arrangement of the parts. In fact, nearly every successful construction has been of that kind which operating by two magnets, may be called the simple electro magnetic engine, in contradistinction to that form which consisting of more impelling magnets, might be called the compound electro magnetic engine. It remains to be proved whether the first or last of these forms is most capable of an increase of power, but before such com-

parison can be fairly instituted, certain laws of magnetism hitherto disregarded, must be attended to in the construction of compound electro magnetic engines. The greater or smaller diameter of the wheel having an important bearing upon the power and velocity, requires also to be experimented upon, in order to obtain a fair comparison of the two forms of construction.

In the construction of the battery, much yet remains to be done. Scientific men have hitherto agreed to a few general principles only, and every day we notice some new galvanic battery, which has its peculiar advantages. It has long been determined that a much larger surface of copper than of zinc is necessary, but the exact proportion is not so certain. The difficulty of determining this, depends upon the greater distance between the metals when the surface of one is much greater than that of the other, accordingly the ratio is variously estimated from 2 : 1, to 16 : 1. By simply cutting the copper into strips and placing them with their edges opposed to the zinc plates, the maximum of surface of copper might undoubtedly be obtained without any sacrifice in the distance of the plates.

Though less economical in point of weight of metal, yet from the facility of construction, wires might be used instead of strips of copper. All preceeding experiments have determined that a considerable gain would result from some such form of battery, but although in the electro magnetic engine every thing depends upon the economical use of this part of the machine. Its importance appears to have been entirely overlooked.

(To be continued.)

THE THAMES TUNNEL.—COPY OF MR. WALKER'S REPORT TO THE TREASURY, ON THE WORKS AT THE THAMES TUNNEL.

(Continued from page 96.)

Mr. Brunel estimates the expense of the shaft, including the steam-engine, pumps, &c. at 6,844*l.*, and the pumping well alone, at 2,690*l.*, independent of the drift-way or drain, which he calculates at 4,310*l.*, making together 7,000*l.*, which sum he presumes would be saved by forming the shaft, rather than the well, at the present time, exclusive of keeping the workmen and establishment employed, and thereby reducing the amount which is now charged to the tunnel account. He also mentions the impregnation of the water with sulphureted hydrogen, which has proved very injurious to the health of the workmen, as another reason for making the drift-way, as it would be the most effectual means of drawing it off. The report states, that "the fact of sixteen feet of the tunnel having been completed under the described difficulties, is a proof that it can be accomplished, though, owing to the disadvantages, at an enormous price, and that it never could be intended in the conditions of the treasury that he should be deprived of the means of completing the work at the estimated cost."

Mr. Brunel's report, dated 9th August, 1837, recapitulates the substance of his previous report, and adduces the successful result of pumping-engines and drift-ways erected for the purpose of taking off the land-springs that impeded the formation of the Kilsby tunnel in the line of the Burmingham railway, as a proof of the good effect that would be felt in the works of the Thames tunnel by a pumping-engine on the Middlesex side. He states also, as an argument for the works he proposed in his former report, the

importance of giving the disturbed and artificial ground time to consolidate, and now proposes, on the completion of the Middlesex shaft, to commence the tunnel on that side also, with a view to greater expedition and economy, and to keep the full complement of men more regularly employed by having the two ends to work at. This, it is stated, would reduce the cost of conveying the men, materials, and excavation to the shaft on the Surrey side. In this report Mr. Brunel further states, that as soon as the plan he has proposed is in satisfactory operation, the formation of the carriage roads might be commenced simultaneously with the tunnel, and that by the various means he now proposes, a saving might be effected in the time of four and a half years, which, in my report of April 1837, I considered requisite for the completion of the tunnel and approaches, and that, consequently, there would be an earlier receipt of toll and a saving of current expenses and machinery to the amount of 15,000*l.*, by the works being completed one year and a quarter within the time I had calculated. Various accounts and calculations in proof of his several positions are appended to this report of Mr. Brunel, and an estimate that, to carry on the works as he recommends, the sum of 94,000*l.* will be required during one year from August 1837.

The lords commissioners of Her Majesty's treasury having refused their assent to the tunnel being begun on the Middlesex side, Mr. Brunel in his report, dated 7th September, 1837, repeats the other recommendations of his former reports.

The last report of Mr. Brunel that is referred to me, is dated 15th November, 1837, the fourth irruption of the Thames having taken place on the 2nd of that month. In this report he considers the third irruption [that of the 23d of August] as not having been unfavorable in one point of view as it would enable substantial ground to be substituted for the loose silth that had worked into the tunnel by the irruption; in proof of which he states that the work done before the third irruption cost 9000*l.* per lineal foot, while what was done between the third and fourth irruptions cost only 630*l.* The former recommendations and arguments are repeated, and in addition it is now stated that the fourth or last irruption was caused in a great degree by the part of the tunnel then in progress being under the portion of the river chiefly used for navigation, and that the depth being small, the artificial bed of the river, or roof of the tunnel, was liable to be disturbed by passing vessels. This, Mr. Brunel now proposes to remedy, by deepening a part of the river where the tunnel is formed, moving some of the ships in the tiers near the tunnel from the northern to the southern side of the river, according to a plan which accompanies his report, throwing the space which is required to be kept clear for the navigation from the north side towards the middle of the river, over where the tunnel is formed, so as to leave the space which is in advance of the works free for tunnelling operations, and then substituting a thicker roof of clay and gravel raised above the present level, to which, from the navigation not being then over that part, there would not be the same objection as at present. The thicker roof Mr. Brunel proposes to make 100 feet in length, or in advance of the shield, and 100 feet on each side of it. He calculates on a great saving in the end from this artificial covering, which he estimates at 1,800*l.*, and ascribes much of the late trouble and expense to the passing ships, and the want of a sufficient thickness in his roof, which the navigation prevented his having.

The reports are drawn up in great detail, and the above abstract is to be considered not as a substitute for them, but only as bringing the leading

points to recollection in one view, without the repetition which the reports themselves, being of different dates, naturally contain.

It is now my duty to state my opinion; which is, to recommend Mr. Brunel's proposal to be adopted, as the most economical and creditable way of executing the works, if it be the determination that the Thames Tunnel [a work which for many years has attracted much of the public attention in this, and still more in other countries, and upon which upwards of 80,000*l.* of public money has been advanced,] shall be completed, without making cost an element in the question. I would then even advise more effectual works in front of the shield than Mr. Brunel's description and estimate of 1,800*l.* contemplates; for if the work is to be considered a national or government work, a repetition of the danger, the late irruptions, and the enormous expense of the work, would be discreditable, and, as it may be, it ought to be prevented. In addition to Mr. Brunel's proposals I would recommend, after the removal of the clay that has lately been thrown in, and a portion of the silth, that two rows of close whole timber piles should be driven between where the ground begins to rise and the present shield, one row on each side of the line of tunnel, with space between sufficient for the shield to travel, and to as great a depth as they can be conveniently driven, the heads being level with low water. These, with a return of shorter piles at the end, would form a dam against the silth. The piles being driven, I would continue the dredging of the silth in the space enclosed by the piles, and then fill up with clay, gravel, &c., as at present, to a sufficient height, and afterwards give the mass time for consolidation before attempting to advance the shield, which, in my report to the commissioners for the loan of exchequer bills, I stated to be an essential element for success in the undertaking. In the progress he has made through very bad strata, Mr. Brunel has fully tried and proved the great power of his excellent shield; but the strata, rendered worse by the irruptions and the cause assigned by Mr. Brunel, are now too bad for even the shield to overcome. By the substitution of good artificial soil to work through, and keeping the silth, or sand, back by the piles, there would be much less difficulty or danger; and with proper precautions, my decided opinion is, that the tunnel may be completed notwithstanding the late irruptions, and with comparatively little difficulty or risk.

Here the question naturally presents itself, at what cost? and to answer it with the probability of accuracy, is still very difficult.

The amount of the company's capital expended previous to any advance of public money was 180,000*l.*

On the 27th February, 1837, when - - - - - -	64,600
received from the commissioners for the loan of exchequer bills had been expended, I estimated the addition then required to complete, at - - - - - - - - - - - -	310,000
Making, exclusive of the company's capital - - -	£374,600

Between the 27th February and the 2nd November, 19,300*l.* have been expended, making 83,900*l.* of public money expended to the 2nd November, but the quantity of work done with the above 19,300*l.* is only 19 feet 6 inches, making, [inclusive of 1,400*l.* for pumping, excavating, and claying, after the third irruption,] nearly 1,000*l.* per foot, which very much exceeds all previous estimates, and proves what I stated in evidence before the select committee of the house of commons, that no prudent man would committ himself to the accuracy of an estimate of this work, while it shows also the impolicy of attempting to drive on the shield

through the present bad soil without a sufficient covering, and time for consolidation.

In the present situation I consider that the sum of 150,000*l.* should be taken as the estimate for completing the tunneling; and that the shafts and other works remaining to be done, together with the purchases, should not be estimated under 200,000*l.*, making, with the 84,000*l.* of public money already expended, and the company's capital previously expended, a total of 614,000*l.* for the estimate of the work, or upwards of triple the original estimate, and this is allowing but a moderate sum for contingencies, which have heretofore been very heavy.

I have estimated the great descents at double Mr. Brunel's estimate. and yet I have, from the nature of the work, as much doubt as to the sufficiency of that sum as of any other item in my estimate.

If, however, in place of determining to complete the tunnel without reference to cost, which the foregoing observations suppose, the lords of the treasury resolve, as heretofore, to confine their operations to the advance of the tunnel, so as to remove any doubt of its getting through, before they sanction a further heavy outlay, then, although I agree with Mr. Brunel that the pumping well or the shaft, with the drift-way, or drain, would lessen the springs, I do not by any means think them so essential to the progress of the work as to agree in recommending their being proceeded in at present. Up to the time of the second irruption, in January 1828, the works were under the uncontrolled management of the directors and engineers, and during that period nothing had been done on the Middlesex side with a view of draining the water from the tunneling, although it had then advanced to the middle of the river, only 155 feet having been done since, but in the report of 1831, the drift-way or adit is proposed and estimated, with the pumping well, at 6,000*l.* Mr. Brunel informs me that the drainage in the tunnel is now very small, and the short time in which the water after irruptions has been taken out, proves that the present pumping engine is fully equal to the work.

More rain, by two inches, fell during the last six months of 1836 than of 1835*, an increase, but not such as to cause a very important difference in the workings, which I ascribe almost entirely to the ground towards the Middlesex side being of a looser and more sandy and silthy nature than towards the south side; this, it has always been said by the Trinity officers and others acquainted with that part of the river, would be found to be the case; so that, although the spring water has been an evil and an hindrance, the Thames water has been another and probably a greater, and is the present enemy, which makes the cases of the London Dock or the Kilsby Tunnel parallel to a certain extent only. It is not in preventing the communication with the spring, but with the river water, that the artificial roof of clay, &c., has been useful.

I agree that the air for respiration would be improved by the drift way, and probably the present air-pump, which is worked by the steam engine, rendered unnecessary; but this pump, ingenious as all Mr. Brunel's applications are, appears to completely answer the purpose, and would probably be found quite as effectual in abstracting the sulphureted hydrogen, as a drift-way at the bottom would be.

I cannot agree as to the saving of expense by the shorter distance to the Middlesex shaft; the difference of distance in the present situation of the shield would be only seventy yards, and as an excellent railway is laid, and machinery attached for working it by the steam engine, I am sure that the

* The quantity of rain that fell in the last six months of 1835 (as kept at the Royal Society's rooms) was 10 1-2 inches, and in the corresponding period of 1836 it was 12 1-2 inches. In the same period of 1834, a very dry year, it was only six inches.

conveyance of the excavated soil along the bottom of the tunnel to the low ground on the Surrey side must be at least as cheap as to the Middlesex side, where the ground is chiefly covered with buildings, and does not require to be raised, and that, as a passage to and from their work, the workmen would generally prefer the spacious lighted tunnel to a drift-way, until the difference of distance is much greater than at present.

That the well, or shaft, on the Middlesex side would give employment to the miners and other workmen when they cannot be employed in the shield and thus lessen the amount now charged to the tunnel, I entirely agree; but my opinion at the same time is, that they may be fully employed in securing the ground in advance of the shield, according to Mr. Brunel's plan, or with the additional piling, such as I have suggested. It appears to me that sinking the shaft, driving a drift-way, making a new shield, and proceeding from the Middlesex side, would amount to a committal to go through with the undertaking, and ought not to be begun until that, as a previous question, has been determined.

In stating this, I am in some measure influenced by the opinion that Mr. Brunel's estimate for the works on the Middlesex side is too low. He estimates the pumping well and drift way at 7,000*l.*, and the shaft engine and pumps at 6,844*l.*, and gives a decided preference to the shaft. Now the shaft on the Surrey side is stated in the account to have cost 20,000*l.*, and evidently the drift way, 4,310*l.*, should have been added to the shaft, as to the well plan. The Middlesex shaft may, and probably will, be less expensive than the Surrey one was; I think it unsafe to trust calculation against experience, so far as to take one-third of the actual of the Surrey, as the estimate for the Middlesex, shaft.

Of the propriety and importance of changing the channel for the passage of vessels, from the part of the river in front of the shield which has yet to be tunneled through, over to the part which is tunneled, and forming a body of compact gravel and clay in front of the shield, in the way Mr. Brunel proposes, to a greater thickness than is now compatible with navigation, there can be no question; and I am glad to learn, by a letter received from Mr. Charlier, that the Navigation Committee have agreed to the proposal, and as Mr. Brunel considers that this will remove much of the cause of the late irruption, by enabling him to have a better covering of clay, and preventing vessels grounding upon the artificial bed, and estimates the necessary work at only 1,800*l.*, I have no hesitation in recommending to the lords of the treasury to sanction it, even with the addition I have proposed, should Mr. Brunel be disposed to adopt it. I think the expense of the piling and clay may be taken at about 10,000*l.*, and I feel assured that, if the completing of the tunneling be the object, this outlay will be more effectual, and much less in amount, than proceeding with the works on the Middlesex side. From the length of the river proposed to be covered with clay, if done according to Mr. Brunel's plan, being three times greater than with piling suggested by me, I think the difference of expense of the two plans would be small.

Having now given my opinion on the various points that have been referred to me, I would beg to add that, as the Thames Tunnel is Mr. Brunel's work as respects design and responsibility, any measure that may be proposed for executing the work should, in my judgment, have his approval. If that approval is refused, unless the lords of the treasury will consent to works which exceed the amount they have yet thought proper to agree to, almost any course would be better than letting the complaint be repeated, "that the engineer has been deprived of the proper means of completing the work at the estimated cost." (Signed) JAMES WALKER.

December 1837. *Rep. Pat. Inv.*

THE ORIGIN AND USE OF THE STEAM DREDGING MACHINE.—COMMUNICATED BY THOMAS HUGHES, ESQ., CIVIL ENGINEER.

The honor of having first applied steam power to the purposes of dredging has been assigned to various engineers at different times, but it will be found on examination that the greater part of those who have hitherto laid claim to be considered the contrivers of this great addition to the resources of the engineer, have no other foundation for their claims than that of having at periods not long subsequent to the erection of the first steam dredging machine, constructed engines on the same principle.

From the evidence of living witnesses, who are no other than the very men who first worked the dredging machine by steam power, as well as from documents in my possession, I can prove beyond the possibility of doubt, that the first steam dredging machine ever used was constructed by my own father, the late John Hughes, in the execution of several contracts which he undertook for the Corporation of the Trinity House.

The following extracts, from a report by my late father, details the necessity which gave rise to the introduction of this new power, and goes on to show the difficulties he met with in the practical application, and how at length they were all overcome by the production of a dredging engine, which may almost be denominated perfect, when we consider the trifling value and importance which can be attached to any improvements made up to the present time.

When the docks at Blackwell were being formed for the East India Dock Company, it was found necessary to deepen the bed of the river Thames at the moorings opposite the dock gates. With this view the Corporation of the Trinity House were employed for nearly two years, at the expense of the Port of London Committee; but at the end of that period they abandoned their pursuit, as being impracticable, after incurring an expense of from sixty to eighty thousand pounds, because their ballast spoons and other implements were not sufficiently powerful nor properly constructed to penetrate the strata, which, at this part of the river, consist of strong blue clunchy clay, intermixed with layers of rock. Well knowing that these strata were impenetrable to all the ballast-lifting implements of that day, and that the Corporation of the Trinity House had, at the suggestion of the House of Commons, advertised for engineers and others to furnish plans for raising ballast upon an improved principle, I immediately in the abscence of my well known and respectable partner, Mr. William Bough, then attending to a large contract we had at the Dartmoor prison, wrote and suggested to him a mode or principle of a floating steam engine to work a dredging machine, that I thought would fully answer the intended purpose; to this he readily agreed. I immediately set about preparing it, which I was able to do in about three months: and as soon as it was ready, I proposed to the Port of London Committee to deepen and finish the East India moorings. They accepted my proposals, and I became the contractor. When I was ready to commence operations, the Port Committee came down to see the working of the engine, and were exceedingly sanguine about the success of this (at that time) novel and singular contrivance. Several trials were made in their presence, and I had the mortification to see many parts of the engine, which had cost me much expense and intense thought, torn to atoms, and links of chain, one and a half inch square, broken and snapped off, just as easy as the stalks of so many tobacco pipes, by the expansive power of the steam; finally, the machine was almost torn to pieces, and rendered useless, which was a great disappointment to me as well as to the Port Committee. Having, however, been bound under a penalty to execute the work, it was of no use to reflect on the

disasters of this day's trial, which, after all, gave me an opportunity of seeing that the engine had sufficient power to penetrate the strata; but at the same time many improvements were wanting to make the machine equal to its task, it was therefore laid up in Mr. Perry's Dock at Blackwell, and in the course of a few weeks I had my additional friction blocks fixed to prevent breakage, and several other improvements made, which, on the next trial, proved successful, to the greatest degree of perfection, and enabled me effectually to accomplish and complete my contract, to the entire satisfaction of my employers.

About this time Messrs. Milne Huddart and Rennie, civil engineers, were employed by the Navy Board to inquire into the cause and nature of the accumulation and deposit of mud, vegetable, and marine substances, at his Majesty's moorings at Woolwich. They were engaged a long time in making the necessary observations, and obtaining the desired information; and subsequently made a long report thereon, which stated that the deposit of mud, &c., in the river at Woolwich, had so increased of late years, as to render the Dockyard useless, and unfit for Government; and where there was a depth of 15 or 20 feet of water, 12 or 14 years ago, there was now no more than 6 or 8 feet. This report ended by submiting to the Navy Board the propriety of allowing them more time to make an actual survey and soundings of the river, which was granted. Messrs. Giles, then eminent land surveyors, were actively employed for nearly twelve months on this tedious and expensive survey. I had by this time constructed, at an expense of eight thousand pounds, a large and powerful floating steam dredging engine exactly on the same principle as the first, on board the Plymouth bomb vessel, which was purchased from Government for this purpose. It was far superior in power to the first, that being only a six horse power, and this one a thirty horse power. I therefore made a proposal to the Board to remove all the deposit at the King's moorings, off Woolwich, and offered not only to reinstate them, but to deepen the river several feet below the original channel. At the request of Charles Cunningham, Esq., the Commissioner at Woolwich, I brought my new dregding machine from Mr. Perry's Dock, where she had been erected, to make trial of the strata and deposit at Woolwich; the trials were continued nearly a fortnight, during which time it was clearly proved, to the satisfaction of the officers of the Dockyard, that the engine was not only capable of removing gravel and sediment, but was actually competent to penetrate several feet into the original bed of the river, which in this situation is an accumlation of mud, gravel, flint, and chalk. In one day we actually excavated and lifted the incredible and astonishing quantity of two thousand tons from an average depth of 30 feet of water, which can be proved by the Government accounts kept by the master attendant and other officers at Woolwich Dockyard. Having so far succeeded we tried no other experiments, but made further proposals to reinstate the depth of the moorings, &c., which seemed [with the sanction of the officers] to meet with the entire approval of the Board; but by this time the civil engineers before mentioned had brought in their voluminous and conclusive report, stating, that Woolwich was unfit for the purpose of his Majesty's Ordinary, and that the sediment off Woolwich Dockyard had so accumulated of late years, that it would take a period of five years to remove it, and that at an outlay of at least 152,000*l.*; and after all it would be so uncertain in its effects, that they declined entering into any further particulars, but recommended its being abandoned altogether, and that the Naval Dockyard should be established at Northfleet.

It is well known to every member in both houses of Parliament, at that period, with what violence the propriety of this immense work was agita-

ted, which was estimated at the vast sum of seven millions sterling, or upwards. Pamphlets were written on the subject and circulated in all directions; one, I believe, by the late Lord Melville; another, by the late George Rose, Esq.; and several others. We had, however, the satisfaction of being addressed officially, by the Navy Bord requesting us to send them our report to have it compared in all its bearings with the detailed reports of the engineers before mentioned; with this we of course complied, and offered in open contradiction to our opponents, to reinstate the harbor in eighteen months. This proposition and statement [so much at variance with those of the other engineers] astonished the Navy Board, and they finally declined to decide on the eligibilty of one report or the utility of the other: and with this impression, I believe, they laid the whole business before the Admiralty Board. I ought to add, that the plan of the new Dockyard and naval arsenal at Northfleet, was in such a state of forwardness, that the land at Northfleet for the intended docks was actually purchased by Government, and it was at one time fully expected that the works were to commence. But, notwithstanding all these preparations, the Board of Admiralty decided in favor of the mud engineers, with which name we were honored in some of the pamphlets of that date. The grand work at Northfleet was consequently abandoned, and we, in the end, entered into a contract with the Navy Board, whereby we undertook to restore the Woolwich moorings to their former state. How far this has been accomplished may be easily ascertained by application to Mr. Cunningham, who, I believe, at one time, much to his credit, stood alone unsupported against the opinion of those engineers who advocated the abandonment of the Dockyard at Woolwich.

JOHN HUGHES.

The preceeding extract will show that the first steam dredging engine with frames, links, and buckets, was used by my father in the year 1804, in a contract under the Corporation of the Trinity House, at the moorings opposite the East India Dock gates.

Of the advantages that have been derived by the Government and shipping interests of this kingdom, from the means afforded by the steam dredging machine, of deepening and clearing the various harbors, I am quite unable to give anything like an adequate idea. With respect, however, to its application by the civil engineer to the numerous operations connected with the improvement of navigation, it is quite certain according to the experience of upwards of thirty years, since its first introduction, that a more effective and necessary machine has never been placed under his command.

I propose now to notice the further improvements that were made in the steam dredging engine under my own inspection, whilst managing the dredging operations on the Caledonian Canal, under my late uncle, Mr. William Hughes. In order to convey a proper idea of the great value of the system of steam dredging, as practised on this important work, it will be necessary to give some description of the nature of the country through which the canal is carried, from which it will be seen that difficulties almost insurmountable would have occurred to impede the execution of the canal, had not the dredging proved effectual to the full extent of the most sanguine anticipation.

The line of country which had been fixed on for the course of the canal, comprised three deep and extensive lochs or lakes, extending longitudinally with the canal for the length of thirty-seven miles and a half, whilst a distance of about twenty-three miles intervened between the lakes. Thus it was necessary, in order to complete the communication between the eastern and western shores of Scotland, to excavate between one lake and the other,

and afterwards to deepen all the shallows that occurred in the direction through which the canal was to be carried.

The method of dredging which had been pursued by my father, as before described, on the river Thames, and subsequently by Mr. Rennie at the Hull docks, was found perfectly successful in every situation where the machine could float above the spot at which the dredging was required. The position of the buckets, however, required considerable alteration before the engine could be rendered capable of cutting her way across a neck of land, or through the various shoals which occurred on many parts of the lakes. It was accordingly found necessary so to construct and fix the ladder or bucket frame, that when lowered to the working position it projected several feet beyond the bows or stem of the vessel—an experiment, of which the ultimate success was at the time considered very doubtful, and concerning which great anxiety was felt by all those interested in the proceedings. It, therefore, afforded universal and infinite satisfaction to find that the engine worked with the most perfect ease, cutting a passage on the very first trial out of a piece of the canal [which had previously been filled with water for the purpose of floating her] through a neck of land into the eastern end of Loch Doch Four. This work having been accomplished, the engine was successfully employed in removing several extensive shoals which occurred in the lake. At the eastern end of Loch Doch Four where the water from Loch Ness falls into it, close to the ruins of Old Ness Castle, occurred perhaps the most difficult case of dredging that can well be imagined. This was occasioned by the necessity of carrying the canal along the bed of the river Ness, which discharges the water from Loch Ness, into the lower level of Loch Doch Four. The bed of the river was composed of an exceedingly hard stratification known by the term mountain clay; and it would be difficult to conceive anything more calculated to resist all efforts to remove it than this very compact and almost impenetrable substance. It occurs in great masses almost without any appearance of stratification, and entirely free from vertical cracks or fissures. Gunpowder applied in the ordinary mode of blasting was found to produce little or no effect on this clay, as it blew out of the orifice made to receive it without loosening any quantity of the mass.

The river Ness flowing over this primitive and hitherto undisturbed bed, falls into Loch Doch Four with rather a rapid current, and against this the engine had to fight her way, while the duty to be performed was the excavation of the river-bed, to a depth varying from four to twelve feet, and very often the sides had to be widened, and in places where considerable bends occurred in the course of the river, a new channel had to be formed with a breadth at bottom of fifty feet according to the regular section of the canal. It was soon evident when the engine was set to work against the current, and required to tear up the hard bed of the river, that the exercise of every possible contrivance was necessary in order to the fulfilment of this difficult task.

It was at first found impossible to keep the vessel, containing the engine steadily moored against the current, in consequence of the slipping and giving way of chains, cables, and anchors. The machinery, which was of the very best description, and constructed by the Messrs. Donkin, was quite unable to withstand the immense force applied to it, in order to make the buckets cut into and bring up the excavated clay. All the ground tackle, comprising a full complement of anchors, cables, and hawsers, was first-rate, both in workmanship and materials; the links were of the best Swedish iron; all the bolt-holes were steel-bushed; while the bolts themselves were of the best tempered steel, and case-hardened.

The whole of the buckets were not only made of the best Sweedish plate-iron, but had strong pieces of tempered steel-plate riveted to their edges. The friction-blocks throughout the engine were manufactured and fixed with most surpassing care, and could always be adjusted to act with the greatest nicety. Notwithstanding, however, all the perfection of this engine, and the constant care with which every operation was performed, the most vexatious and apparently insurmountable inefficiency, was the result of her first labors in the situation above described. It was no uncommon occurrence to witness, in rapid succession the tearing away of the buckets, the stripping of the cogs from off the wheels, the snapping of the chains, breaking of bolts, and giving way of the anchors and cables, while on more than one occasion the whole string of chain, buckets, and bolts, was carried overboard.

No sooner were the necessary repairs executed upon the shattered machinery than it was again torn to pieces, and after all no impression was made, no effect produced, on the solid and obstinately resisting mass, against which the engine was contending. Without dwelling upon the various unsuccessful contrivances which were introduced, it will be sufficient to mention at once, that none of these proved effectual until the expedient was tried of removing every alternate bucket from off the chain, and fixing, instead of it, two cutters formed of plates of iron and hardened with steel, which projected at right angles to the line of the chain, and, as this revolved, cut vertically into the ground below. Each pair of cutters, therefore, effected two simultaneous incisions longitudinally in the direction of the vessel, and the lip of the succeeding bucket descending immediately afterwards, scoops up the mass separated by the cutters, and carries it to the top of the frame. After this alteration the work of the engine was performed with much greater efficiency than before; but, in consequence of the hard and incompressable nature of the clay above described, the counter resistance offered to the buckets and cutters would have been sufficient to tear them off and otherwise derange the machinery, had this not been prevented by the action of the friction-blocks. By means of these, whenever a visible tightening and straining of the chain throughout its whole length, denoted that some extraordinary resistance was opposed to the motion of the buckets, the engine continued to work and the wheels to revolve, while the chain and buckets remained stationary. The dredging vessel was then allowed to drop back with the stream, in order to loosen the bucket, which, being thus extricated from the incision made in the ground, passes back without resistance.

The vessel is then hove up to her original position, and the next descending cutters render the previous incision more perfect, and the bucket immediately following these cutters commonly succeeded in tearing up the obstinate mass. Sometimes, however, it happened that the vessel had to be dropped from her work, and hove to it again several times before this effect could be produced.

These operations, tedious and difficult as they were, succeeded in forming the complete communication between the two lakes in the course of about four months. The distance thus dredged was about 300 yaards, and the total quantity removed about 20,000 yards. It must, however, be noticed, that the returns of the work done did not exhibit so large an amount as the above, and this is accounted for by the fact, that a great deal of the material loosened and dislodged by the cutters and buckets was carried down by the stream into deep water, instead of being raised in the buckets to the top of the frame. The excavated earth being in this way as effectu-

ally disposed of as if it had all been hauled up by the buckets; it may not appear surprising to learn that the current of the river, although seeming at first sight so obviously an obstacle to the process of effective dredging proved in the way described a great auxiliary to the power of the engine.

Another instance of the immense advantage which may be derived in some situations from the employment of the dredging engine occurred at the west end of Loch Ness. In this part of its course for a short distance out of the lake the canal runs side by side with the river, which descends from Loch Oich, the summit lake, to Loch Ness. The canal attains the level of Loch Oich by means of six locks, five of which are situate above Fort Augustus, about half a mile from Loch Ness, and the sixth at Kytra, about half way between the two lakes. The locks were founded and carried up beyond the reach of water before the canal was excavated on either side of them; and here it will be useful to observe the difficulties which would have presented themselves had not the power of dredging been applicable to this work.

In the first place, any attempt to excavate in the ordinary way between Loch Ness and the ascending locks would have been immediately followed by a deluge of water from the river, and it was certain, on account of the open and inadhesive nature of the strata between the river and the canal, that the water penetrating into the excavation made for the latter would have stood at least as high as the level of Loch Ness, which is the lowest drainage it could possibly obtain. Thus the operations of excavating must have been carried on under a depth of twenty feet of water—a case in which manual labor could not possibly be employed.

On the other hand the expedient of carrying the canal on a higher level, by building two of the locks immediately at the end of Loch Ness, and in this way obtaining drainage into the lake, would have been attended with almost equal objections, for the immense coffer dams which would have been required in getting down the foundations in such a situation would have seriously increased both the time and the cost of execution. As it was, however, by means of the dredging engine the canal was easily excavated to its full depth and breadth, from the end of Loch Ness to the tail of the first ascending lock.

The application of the dredging engine in the case just described leads us to consider one of far greater importance, where a most difficult and extensive work would have been entirely avoided, had the power of the dredging machine been as well known at that time as it has since become. Every history of the Caladonian canal dwells with great minuteness upon the difficulties experienced in building the sea lock at the eastern end of the canal where it terminates in the Beauly Frith, a part of the Eastern Sea. At this place an embankment was actually carried out into deep water, and after sufficient time had been allowed for its consolidation, the excavation for the lock was formed in the middle of it. This expedient, ingenious as it certainly was, would have been quite unnecessary if the lock had been built on the solid ground inland, and a passage had been dredged out into deep water. Although it is probable, considering the state of engineering knowledge at that time, that the plan adopted was the best that could then be devised, it is certain that a much better work could have been constructed in the solid ground before entering the Beauly Frith, and in corroboration of this it may be mentioned, that the sea lock at this day has a considerable dip or inclination towards the sea, an effect no doubt occasioned by the after settlement of the artificial mound in which it was placed.

With respect to the dredging on the Caledonian canal very little more re-

mains to be said. In various places on the west side of Loch Oich its powers were brought into requisition, but to describe the circumstances of its application at length would be merely to repeat what has already been told, with reference to Loch Doch Four, and Loch Ness.

Without any disposition to disguise the fact that difficulties serious and annoying occasionally presented themselves, I am quite safe in asserting that in every case a persevering and determined application of the dredging engine, in the capability of which every one engaged placed the most implicit reliance, succeeded without exception in a complete fulfillment of the duties expected and required. As it may be interesting to know the quantities of work performed by the engines on this canal, the following numerical statement may safely be depended on. The total quantity of dredging on the Caledonian canal exceeded one million of cubic yards, and the engines employed were only two in number, a six and ten horse power. The former of these was employed in the dredging out of Loch Ness up to the first ascending lock, in which district the quantity dredged amounted to 170,000 cubic yards and occupied eight months. This engine was also employed in dredging through the shoals of Loch Doch Four, and between this lake and Loch Ness. The ten-horse power engine was built at Loch Oich, in the year 1816, and was employed in dredging into the lake through the shallows, and between the summit level and Loch Lochy descending westward. The greatest quantity raised in one day by the ten-horse-power engine on the Caledonian canal was 1500 tons.

In reviewing the extraordinary peformance of the dredging engine in every situation where it has hitherto been employed it appears to afford to the engineer means of the most powerful and extensive capability in the construction of a class of works which must ever hold a place of great importance in the rank of engineering operations. I allude to docks and harbors, in the construction of which, during late years, the greatest acquirements, both practical and scientific, have been called into action. The well-attested performances of the dredging engine clearly establish the fact that this machine, being set to float in a basin or a channel of water, is capable not only of tearing up and deepening the bed, however hard or solid but also of cutting away the adjacent land, and extending either the length or breadth of the body of water in any required direction. In the same way the engine would be quite competent, when placed out at sea, to work inland, either to clear out the *embouchure* of old rivers, docks, or harbors, or, as a still bolder undertaking, to excavate new channels where the old ones from any cause have been impeded and rendered useless. The design of constructing docks, harbors, and basins of any kind in sheltered situations, at any convenient distance from the sea, may be safely carried into effect, relying on the power of the dredging engine to perfect the communication with the sea, at an expense not exceeding that of ordinary excavation.

To enter into details respecting the cost of dredging in various situations would be out of place in a paper of this kind, which professes to be a mere outline of its advantages. But I shall at any time feel great pleasure in affording to any individual, or public body, who may think proper to communicate with me on the subject, the benefit of my experience and practical acquaintance from earliest youth, with every particular relating to the practice of dredging by steam power.

THOMAS HUGHES.

4, Acre-lane, West Brixton.
December 15, 1838.

St. Petersburg Railway—At a General Meeting of the Shareholders in the Zarskoe Zelo Railway, held at St. Petersburgh at the end of April, it appeared by the report of the Directors that the cost of the formation of the road and its material had amounted to 5,281,667 roubles. *The original calculations were founded upon the anticipation of* 300,000 *passengers within the year, but during the preceeding* 12 *months the number of travellers betwteen the capital and Zarskoe Zelo had amounted to* 500,000, *and the number which passed along the whole line to and from Paulowsk was* 707,091. The receipts amounted to 920,237 roubles. At the end of the first nine months the receipts exceeded the expenditure by 316,976 roubles. Of this balance 90,000 roubles were applied in paying the interest and reimbursing the loan from the crown; and 140,000 roubles to the payment of interest on shares; 15,848 roubles were divided according to the statute among the Directors; 1,555 roubles were paid to the chief engineer; and 69,572 roubles were carried to the reserved fund.

Monroe Railroad Extension.—It will no doubt, be learned with pleasure by our readers, that the location of the road has just been completed, and all the contracts for grading have been taken or engaged, from Forsyth to the State road in De Kalb. This has exceeded the most sanguine expectations of its warmest friends, and great credit is due to those who superintend its interests, for the energetic manner in which the work has been conducted. No doubt remains that this road could be completed in fifteen months from this time, if sufficient funds were at command, or could be obtained, to procure the iron by the time it will be needed. Great difficulties have been surmounted in the worst of times, in carrying on this work, and we trust that this will be. Great advantages will be acquired by the road, and also by our citizens by its early completion.—*Macon Messenger, 29th August.*

REPORT OF THE ENGINEER TO THE PRESIDENT AND DIRECTORS OF THE LITTLE MIAMI RAILROAD COMPANY.

To the President and Directors of the Little Miami Railroad Company.

Gentlemen—The following statement of the result of the survey for determing the route, and ascertaining the probable cost, of constructing a Railroad from the city of Cincinnati to the town of Springfield, is respectfully submitted.

The located line, from Cincinnati to Milford, occupies, with but few exceptions, the same ground as that surveyed by R. H. Fauntelroy, resident Engineer, under the direction of Samuel Forrer, Esq., consulting Engineer; and is, beyond doubt, the most judicious location that could be made.

From Kulgar's Mills to the point where the Lebanon and Chilicothe Road crosses the river, an instrumental examination was carefully made of both sides of the river, which resulted in giving preference to the east side.—High bluffs and precipitous banks occur more frequently on the west side: in many instances the river makes so near the base of the hills, and is so serpentine in its course, that curves of 500 feet radii must be employed to afford deflections sufficiently abrupt to psas them without incurring a heavy expense for constructing the Road entirely in the bed of the river, or making heavy excavations in side hills that are subject to continued slips.

The two routes are about equal as to grades, but in respect to curvature, a considerable superiority belongs to the line on the east side of the river; the minimum radius employed on the latter side being 800 feet. The line

on the west side is 1.42 miles longer than the east line, and its estimated cost exceeds the cost of the latter $40.142 13. From the intersection of the two lines, near Lockport, north, but one line has been surveyed. The frequent bluffs and slips on the west side of the river, none of which appear on the east, are, in themselves, sufficient to warrant a decision in favor of the latter side. The general direction of the line, while within the influence of the Ohio and Little Miami rivers is quite circuitous; yet there are but few instances where we are compelled to resort to curves of less than 2000 feet radii. In all cases where the curves are abrupt, the grades are nearly or quite level, so that in no instance will the line, curved with the minimum radius, with the adopted grades, offer a resistance to the action of a locomotive engine equivalent to that due to gravity, where the ascent exceeds 20 feet in a mile.

DESCRIPTION OF LINE.

The location commences at the corporation line, near the centre of High street, and runs along the face of the hill nearly parallel with the turnpike for three miles; at the commencement of the fourth mile it crosses the turnpike and Crawfish creek. The valley of this creek, where the line crosses it, is 900 feet wide; it is proposed to pass it with a bridge at an elevation of 30 feet. From this creek the line follows the base of the hill—recrossing the turnpike at J. D. Langdon's; thence up the valley of Duck creek to C. D. Langdon's, where it again crosses the turnpike and enters the valley of the Little Miami river at the "red bank." From the "red bank" it continues along the side hill for one and a half miles, when it enters the bottom land, and continues thereon to the narrows, on the 11th mile; at this place it will be necessary to protect the banks with stone, in order to avoid the encroachments constantly made by the river.

On the 11th mile the line enters the valley of Highland's creek, running along the western side, it crosses the summit between that and Mill creek, in the vicinity of W. Highland's house, and re-enters the valley of the Little Miami river opposite the town of Milford. From the toll-gate, at Milford, the line follows the serpentine course of the river for one mile, when it again leaves the valley and enters the elevated second table in the rear of M. Kulgar's Mills. It keeps at the same elevation until within a short distance of the Little Miami river, on the 17th mile. From this point two lines were run, one on each side of the river. The features of the two lines, to their intersection near Lockport, are quite similar—so that a particular description of both is not necessary.

The *east line* crosses the river at the "Indian Ripple," a short distance below Buckingham's mill, and continues upon the second table, until the narrows are reached, opposite the lands of W. Goldtrap; at this place it will be necessary to build the road partly in the river for several hundred feet, in consequence of a sudden bend in the river and the precipitous character of the banks. Loose rock is to be had in sufficient quantities in the immediate vicinity, to build the necessary protection wall.

From the "Narrows" the line is laid upon first and second bottom, until opposite the "Company Mills," when it again follows the bluff banks of the river for a short distance. No obstacle presents itself at this point to a cheap and permanent location, as the bluff falls with a gentle slope, and shows no evidence of slips. Between this point and the mills of W. Ballard, the ground is highly favorable, being mostly bottoms, sufficiently elevated to be out of the way of high water.

The line crosses Obanion creek, at a favorable elevation, near its mouth, and continues on the bottom with but one minor exception, to a point oppo-

site the mills of Gov. Morrow. On the 27th mile the ground is broken and subject to inundation, but the great abundance of stone which may be had here, as well as at almost every other point on the river, will materially reduce the expense of construction. From the 28th mile, opposite the mills of J. Phillips, to the crossing of "Todd's Fork," on the 37th mile the features of the valley are generally favorable. From the mouth of "Todd's Fork" the same favorable features are observed, both as to grades and curvature, to the narrows, a short distance above Millgrove. Here, for several hundred feet, the bluff banks on both sides make directly into the river, rendering it necessary to adopt a curve of 800 feet radius, in order to secure the most desirable location.

On the first quarter of the 42nd mile, the two lines connect, and the survey continues up, on the east side of the river. At Lockport, on the 4th quarter of the 42d mile, it will be necessary to protect the road from the action of the river.

Proceeding from Lockport north, the valley increases in width, and the hills lose those rugged features which characterise them south of that point. The line continues on the bottom land, crossing Cæsar's creek near the present "ford." On the first quarter of the 51st mile we are opposite the village of Waynesville, and 305 feet above the Ohio river. Between Waynesville and Xenia, a more favorable location could not be desired, the country being mostly open prairie. The earth coming from the ditches will for a greater part of the distance, afford the material for the embankments.

The line crosses the Xenia and Cincinnati road about 700 feet east of the present road bridge—enters Glady valley near its mouth—pursues it to the low summit dividing the waters of Glady and Shawnee rivers, and enters the town of Xenia, on the 3d quarter of the 65th mile, at the foot of Detroit street.

The foundation of the court house in Xenia is 498.1 feet above the surface of the water in the Ohio river, as observed 6th November, 1838. From Xenia north, we continue a straight course parallel with Detroit street—the present travelled road diverging to the west, when we curve to the west, cross the old road, and pursue the course of a ravine down to "Old Town bottom." In crossing the valley of "Old Town run," an embankment of 11 feet is necessary for one thousand feet. Thence the line continues along the base of the hill bounding "Old Town bottom," crossing Massie's creek at an elevation of 14 feet, and continues to ascend until it reaches the high land two miles below Clifton—thence descending gradually to the town of Clifton. The Little Miami river is crossed between the present road bridge and Bates & Lewis' flouring mill.

From Clifton to Springfield the route is very favorable. For the first five miles the line is laid upon open prarie—the next three miles are rolling timbered land: nothing, however, opposing a cheap and favorable location. The line falls into the valley of "Mill run," a short distance east of Springfield, and continues down the run to an intersection with Spring street, the terminating point of the survey. The termination is approached with a straight line and a level grade, and is at an elevation of 534 feet above the Ohio river.

The entire distance from the corporation line of the city of Cincinnati to the town of Springfield is 85.2 miles.

I have divided the line into six divisions, and as the detailed estimates are too voluminous to accompany this report, I have given the amount only for the graduation, masonry and bridging of each division, the cost of superstructure being almost invariable, will be the same per mile for the entire line.

ESTIMATES.

For graduation, masonry, &c., of division 1, extending from the corporation line to Columbia, 3.60 miles,	$24,848 91
For graduation, &c., of division 2, extending to Kuglar's mills, 11.68 miles,	51,158 50
For graduation, &c., of division 3, extending to Lockport, 25.66 miles,	118,565 52
For graduation, &c., of division 4, extending to Greene county line, 13.50 miles,	38,522 76
For graduation, &c., of division 5, extending to Xenia, 10.32 miles,	16,010 10
For graduation, &c., of division 6, extending to Springfield, 20.44 miles,	82,731 44
Total for the graduation, masonry, &c. of the entire line,	$331,837 23
For 85.2 miles superstructure, as per estimate A, $5024 per mile,	428,044 80
Add for depots, side tracks, &c., 10 per cent,	75,988 20
Add for engineering, 5 per cent,	41,793 51
Total for 85.2 miles,	$877,663 74

Or ten thousand three hundred and one 21-100 dollars per mile.*

The above estimates were made to include the cost of a single track, together with the necessary side tracks. The facilities for transportation afforded by a single track railroad when provided with suitable side tracks are very great, and without doubt will be found adequate to the business of the road, however much it may be increased. This is rendered the more certain by the perfection attained in the application and management of locomotive power. It is now so well understood, that the time of meeting at the different passing places may be so arranged as to prevent all danger of collision.

The plan of superstructure for which the estimates were made, is similar to that adopted on the Utica and Schenectady Railroad, and most other roads in the northern and western states. It consists of a sill 4 by 12 inches, either hewed or sawed, upon which rest cross ties 8 feet long and three feet from centre to centre, secured by locust tree nails. The rails are to be 6 by 7 inches, secured in a notch in the tie by white oak wedges. The estimated cost of this superstructure is $5024 per mile, as per estimate A.

I have estimated 31 1-2 tons iron to the mile, which is the weight of a bar having a transverse section of 1 by 2 inches; a bar 2 1-4 by 7-8 inches weighs nearly the same per mile. I would recommend a rail plate with two inches upper surface, 2 1-2 inches base, and 7-8 inches thick: this rail would offer a greater bearing surface upon the timber than one 2 1-4 by 7-8 inches, and would be nearly as inflexible as a bar of 1 by 2 inches. It would be inexpedient to adopt a lighter bar, but should a bar of 2 1-4 by 5-8 inches be adopted, the price, per mile, of superstructure would be proportionally diminished.

The grades are generally favorable, the maximum being 40 feet per mile. This inclination is easily overcome by locomotive engines with loads of from 75 to 100 tons, at a velocity of 10 miles per hour. Recent

* Divisions 2 and 5 were put under contract in December last, and the grading is now well advanced.

experiments for determining the power of traction of locomotive engines have produced much greater results. An engine manufactured by M. W. Baldwin, has drawn over the Columbia Railroad—a part of which has an ascending grade of 45 feet per mile—35 loaded cars weighing 187 tons, at a speed of from 8 to 12 miles per hour, as certified by Mr. J. Brant Superintendent. An engine manufactured by W. Norris, of Philadelphia, drew over the same road a train of 41 loaded cars weighing 198 tons, around short curves, and up an ascent of 51 feet per mile, at the rate of 10 miles per hour. The same engine drew a load of 104 tons up an inclination of 40 feet per mile, at the rate of 15 miles an hour, as certified by the weigh master of the road. Upon the Baltimore and Ohio Railroad locomotive engines are in constant use upon grades of 35 feet per mile, where the road is curved with a ridius of 400 feet, as is shown in the tenth annual report of Jonathan Knight, Esq., Chief Engineer. Mr. Knight estimates the friction due to curvature of 400 feet radius at 6.5 pounds per ton, inclusive of engine and tender, which is equivalent to the gravity of a ton upon an inclination of 1. in 345, or 15.3 feet per mile. Numerous other experiments have produced results that fully sustain the above assertion.

The grades are arranged in the following order:

	MILES.	FEET.
Level,	9	2990
Level to 10 feet inclination per mile,	37	2080
10 to 20,	16	4320
20 to 30,	9	3440
20 to 40,	11	4020

From the above it will be seen that for more than one-half the distance the grades are under 10 feet per mile, and that for but one-eight of the distance do they exceed 30 feet per mile: there are but few instances where the grades exceed 35 feet per mile.

It is an important feature in the profile of the Little Miami Railroad that presents a descending grade for almost the entire distance from Xenia to Cincinnati. This inclination, when considered with regard to the business of transportation, is in the direction favorable to the great preponderance of trade. The heaviest grades occur north of Xenia, in descending into the valley of the "Old Town Run," and ascending from the valley of Massie's creek to the town of Clifton. These grades, from their location, will not importantly affect the business of transportation. Trains for the ascending trade, leaving Cincinnati with loads equal to the maximum power of their engines will, on their departure from Xenia, have discharged a sufficient amount to enable them to pass the heavier grades between Clifton and Xenia, without decreasing their speed.

Trains for the transportation of passengers are seldom loaded to such a degree as to require a diminution of speed upon grades similar to those adopted on this road, and may, without difficulty, maintain velocities of from 15 to 20 miles an hour, while trains for the transportation of freight and passengers may travel at the uniform rate of 15 miles an hour.

It is encouraging to reflect, that the result of the examinations in detail fully demonstrates the practicability of constructing a road that will admit of the favorable application of locomotive power, at a medium expense when compared to the cost incurred in the construction of similar works.

From Xenia north, the features of the country are such as will admit of several lines, although one only was surveyed. My instructions being

more particularly to give the valley of the Little Miami river a thorough examination, together with the limited time allotted for the surveys, prevented an examination of more than the one line; this line is susceptible of some improvement. It is not improbable that a line may be had that will present more favorable grades, and upon which the road may be constructed at a less expense.

The cost of the road, from Cincinnati to Xenia, would be as follows:

For grading, &c., of sections 1, 2, 3, 4, and 5,	$249,105 79
64.76 miles superstructure, at $5024 per mile,	325,354 24
	574,460 03
For depots, side tracks, &c., 10 per cent,	57,446 00
	631,906 03
For engineering, 5 per cent,	31,595 30
	$663,501 33

Making an average of ten thousand two hundred and forty-five 69-100 dollars per mile.

Data cannot be obtained for estimating the probable revenue of a road as accurately as its cost; yet, from the peculiar location of the Little Miami Railroad, we may arrive at a more correct result than is usual in such cases. From the connection of this road with the most important lines of intercommunication of the west—when we consider that during the suspension of navigation of the Ohio river, a large amount of travel between the east and the southwest will become accessary to this road, it is obvious that the number of passengers will far exceed our most sanguine expectations. The Little Miami Railroad will become of importance for the rapid transmission of the United States mail—the receipts for which will also add to the revenue. We can form some idea of what will be the amount of freight transported on this road by a comparison with that transported on the Miami Canal between Cincinnati and Dayton—their locations being quite similar—and it cannot be doubted that the increased business consequent on the increasing population of the country, together with that incident to the advantages due to the certainty and celerity of railroad operations, will, for the entire year, offer a business to this road equal to that done on the canal the past season of navigation.

In 1838 there was shipped from Cincinnati 20,986 barrels of salt, 39,250 bushels of coal, and 8677 tons sundries, inclusive of merchandize, &c. There arrived at the same port 205,891 barrels of flour, pork, whiskey, &c., 3891 tons sundries, inclusive of merchandize, &c.

There was shipped from Dayton in the season of 1835, 106,900 barrels of flour, pork, whiskey, &c.; 3148 tons transient freight. There arrived at the same port 6404 tons sundries, inclusive of merchandize, &c., as is shown in the Canal Commissioner's Report for 1838.

A large amount of flour shipped from Dayton, and the intermediate ports, is manufactured on the Little Miami river, and will, on the completion of the Little Miami Railroad, become tributary to its business. "The amount of pork and wheat produced in Greene county alone, in the year 1838, as taken by the assessor of the county at the request of the Greene County Agricultural Society, was 3,192,353 pounds of pork, and 258,157 bushels of wheat." From the statement of the millers and produce dealers, I find that there is now manufactured for annual exportation, on the Little Miami river and its tributaries, and in the immediate vicinity of the

line of the Railroad, 175,650 bbls. flour, 50,450 bbls. pork and whiskey; and that the exports of transient freight amount to 1473 tons. The average distance of the transportation will be about three-fourths the length of the road; yet it would be unjust to allow but for the present business, as every individual with whom I conversed, assured me that his business would become at least doubled if he possessed facilities for exportations, and we consider ourselves safe in averring that the increase will more than compensate, if we allow the entire length of the road as the distance for the transportation of the present products.

From the above we deduce for the annual receipts of the road, as per estimate B,	$174,700 00
Deduct for managing the road, one year, as per estimate C,	73,110 00
Leaving as a net revenue,	$101,590 00

Which is 10 per cent on $1,015,900.

As the estimate of the revenue is based upon the present busines of the country contiguous to the line of the road, it cannot be doubted that the Little Miami Railroad will amply remunerate all those who aid in its construction.

The surveys and estimates have all been made with much care, and from the vigilance and attention of Wm. H. Clement, my principal assistant, I am confident that no important feature in the topography of the country was passed unnoticed. R. M. SHOEMAKER, *Engineer,*
Little Miami Railroad.

[A]

ESTIMATE FOR ONE MILE OF SUPERSTRUCTURE.

37,171	feet B. M. rails, at $12,	$446 52
42,240	feet B. M. sills, at $12,	506 88
1760	cross-ties, at 25 cents,	440 00
3520	wedges, at $7,	24 64
3520	tree nails, at $3,	10 56
530	splicing blocks, at 3 cents,	15 90
1300	lbs. spikes, at 12 cents,	130 00
2	road crossings, at $10,	20 00
520	lbs. splicing-plates, at 10 cents,	52 00
31½	tons iron, at $85,	2677 20
Workmanship,		700 00
Total for one mile,		$5024 00

[B]

ESTIMATED ANNUAL RECEIPTS OF ROAD.

150,000	bbls. flour, at 30 cents,	$45,000 00
50,000	" pork and whiskey, at 40 cents,	20,000 00
1400	tons bulk pork, and transient freight, at 6 1-2 cents per ton per mile,	7,700 00
80	passengers, (40 each way) per day, at $2 50, 300 days,	60,000 00
5000	tons merchandize, &c., at 6 1-2 cents per ton per mile,	27,500 00
10,000	barrels salt, at 30 cents,	3,000 00
30,000	bushels coal, at 5 cents,	1,500 00
Transportation of United States Mail,		10,000 00
Amount,		$174,700 00

[C]

ESTIMAPE FOR MANAGING THE ROAD ONE YEAR.

1	Chief Agent and Superintendent,	$3,000 00
2	Collectors, at $1500 each,	3,000 00
4	Conductors of trains, at $800 each,	3,200 00
2	Clerks, at $500 each,	1,000 00
5	Engine men, at $700 each,	3,500 00
5	Firemen, at $350 each,	1,750 00
30	Laborers, at $350 each,	10,500 00
3	Collectors, intermediate, at $700 each,	2,100 00
	Repairs of engines, cars, &c.,	10,000 00
	Repairs of road, renewals, &c., at $300 per mile, 10 per cent on the perishable material,	25,560 00
	Fuel, &c.	8,000 00
	Office expenses, advertising, &c.,	1,500 00
	Total for managing the road 1 year,	$73,110 00

THE FIRST ANNUAL REPORT OF THE DIRECTORS OF THE ANNOPOLIS AND ELK RIDGE RAILROAD COMPANY.

To the Stockholders of the Annapolis and Elk Ridge Railroad Company.

The Directors submitt the following report, of the operations for the year ending on the 8th of October, 1838; and a statement of their receipts and disbursements since the organization of the Company.

The books of subscription were opened in Annapolis and Baltimore, and at the Savage, in the Spring of 1837, under the direction of the Commissioners named in the Charter, and subscriptions to the amount of $52,000 were obtained. A general meeting of the Stockholders was called at Annapolis, on the 6th day of June, 1837; when the following gentlemen were elected Directors, Elias Ellicott, John Johnson, Somerville Pinkney, Thomas S. Alexander, Dr. Dennis Clude and John Miller. On the following day John Johnson, was elected President, George W. Hughes, Engineer, and Nicholas H. Green, Secretary.

The Engineer was instructed to organize his corps, and to proceed immediately to locate the route of the road. The preparatory surveys were made in the course of the ensuing autumn, and were submited to the board and adopted on the 6th of February, 1838.

It was not, however, until the 20th of April, 1838, that the board determined to advertise for proposals, for the graduation of the road. Proposals were accordingly received, and on the 29th day of May, 1838, the board contracted for the graduation of the whole line of the road, and for all the masonry on the road. These contracts amount to $158,157. About the middle of June, the several contractors commenced the execution of the work which has been vigorously prosecuted under the direction of the Engineer. The company was deprived of the valuable services of Mr. Johnson, as President, by his resignation on the 26th day of May, 1838; and Somerville Pinkney, was elected in his stead.

The Directors on the 6th of June, 1837, made a requisition on each stockholder for an installment of four dollars per share, the payment of which was completed so as to enable the company in May last, to receive from the State of Maryland the sum of $15,000; a further requisition was made on the 21st day of April, 1838, for the sum of five dollars per share, payable on the first day of July, and of five dollars per share payable on the first day of August last. The first mentioned installment was paid in

time to enable the company to draw on the Treasurer for $15,000; which was received early in September, the other payment was finished so as to put the company in a condition to obtain the further sum of $15,000, on the first instant, from the State.

The corporation of the City of Annapolis by the provisions of several by-laws, lately passed, have agreed to anticipate the City subscription; and under these by-laws the company has received $6,000 in cash, and $2,500 to in certificates of stock of the City, bearing 6 per cent interest, which it is believed can be easily converted into money. The Directors were induced to make the arrangement with the Corporation, by which interest is to be allowed to the City on its advances, from the time thereof until the installments shall be duly payable according to the Charter, for the double reason that it was a relief to the City, and a considerable aid to the Company, its contracts exceeding its immediate available means. They have thus been enabled to meet all the engagements, to the first day of the present month.

The operations of the Company would be greatly advanced, by the stockholders complying with the provisions of certain resolutions, passed on the 1st instant, by which it was proposed, and is now proposed to the stockholders to anticipate their subscriptions, or to advance the installments which will be payable on the 15th November, 15th December and 15th January next. The Directors confidently expect that the stockholders will without hesitation comply with this suggestion, because the State's installments are not payable, until each individual stockholder has paid his installment, and because the State's Treasurer is dependent upon the Chesapeake and Ohio Canal Company, for means to discharge the installments required from the State. The first installment now called in becomes payable on the 15th of November next, and will bring into the Treasury of the Company after that day $17,600.

There has been paid by each stockholder on eash share the sum of $15 amounting to $7,801

By the State of Maryland		45,000
By the Corporation of Annapolis, in anticipation		6,000
And the Company has borrowed		9,000
		$67,801

And there has been expended for the right of way, including expenses of Jury and Sheriff's fees	12,127 90	
Expenses of Engineer's department, in purchasing tents and instruments, pay of Engineer and assistants, provisions of party and other expenses in locating and surveying the road	7,942 62	
Printing, furniture, discount and other incidental expenses	468 07	
Salaries	400 00	
Graduation	20,219 58	
Masonry	6,436 08	
		47,594 25
		$20,206 75

Leaving a balance to the credit of the Company on the 4th October, 1838, in the Farmers' Bank of Maryland of $20,206 75.

This ballance, however, is subject to the payment of the estimates to the 1st of October; which were not fully ascertained when this report was prepared. All which is respectfully submitted,

By order,

SOMERVILLE PINKNEY, *President.*

October 5th, 1838.

OFFICE OF TOPOGRAPHICAL ENGINEERS,
Washington, D. C. Jan. 30th, 1838.

To the President and Directors of the
Annapolis and Elk Ridge Railroad Company.

GENTLEMEN:—On the 7th of June last, I was honored by the appointment of Engineer to your company, with instructions to proceed with the survey and location of the Annapolis and Elk Ridge Railroad, with as little delay as possible; but it was not until the 28th of July, that the instruments and tents could be procured, and other necessary arrangements effected, preparatory to the commencement of field operations.

We found the surveys, which had been executed in 1836, under my instructions, for the Potomac and Annapolis Canal, of great service as regards a knowledge of the general characteristics of the country through which our road must necessarially pass. But, although those surveys answered the purposes for which they were made, yet the principles which should govern in canal and railroad locations, being so widely different, it became necessary to make other and numerous experimental surveys, for the purpose of ascertaining the minute features of the ground, before the location should be commenced. A reference to the maps, will show how completely those lines have covered the surface of the country, by tracing out the secondary ridges and valleys formed by the drainage from the principal ridge, dividing the waters of the Severn from those of the Patuxent. It is unnecessary to enter into a detailed description of those surveys, as the map sufficiently explains their nature, and the objects for which they were made.

The maps have been drawn on the large scale of 1 mile to 6 inches, which admits the delineation of the surface of the country with great minuteness and precision, and will enable the Board to form a correct opinion of the character of the line which I have selected and traced for the definitive location. The yellow color designates the experimental lines, the red, the trace of location, and the blue, the canal surveys.

Profiles have been drawn of the location, but not of the experimental surveys, as it would have required more time, without any adequate result, than we had leisure to bestow for that purpose. Profiles have been drawn on a horizontal scale of 1 mile to 6 inches, and a vertical scale of 25 feet to one inch, producing a distortion in the vertical plane from the horizontal of 35 1-6 : 1. This disproportion has been given for the purpose of showing distinctly all the inequalities of the ground, and to enable us to calculate *rigourously* the amount of work necessary to be done. The black figures on the ordinates of the profiles, denote the levels in relation to the plane of reference; the red figures, show the depth of cutting or filling, according as they are placed above or below the grade line; and the amount of cutting and filling is also designated on the profile. It has been my object to give on the maps and profiles, all the details which may be necessary to a proper understanding of the subject.

The location has been divided into sections, with a view to equalize as nearly as possible, the excavation and embankment. To do this precisely is of course impracticable, but it will be seen that on the more difficult and expensive portions of the road, we have been very successful in our efforts.

to establish this equilibrium, I have given on the several sections both the excavation and embankment, but the estimates of cost are made only for the larger prism, having a view in arranging the prices, to the distances it would be necessary to haul the cutting (if it be the larger quantity,) to form the filling, and *vice versa*. The contractor in making his bid is guided by the same consideration, and expects to be paid only for one quantity. On some roads it has been customary to call all the work excavation, and if there should be more filling than cutting on a particular section, a measurement is made of a ridge or hill in the vicinity, whence the dirt is taken for the embankment; and the amount thus taken for the embankment, over and above the excavation from the road bed [if any] is paid for as excavation. This is more simple, and perhaps rather more correct than the usual method, because the *precise* amount of work is then paid for; whereas if the embankment be measured before it is well settled, the contractor is paid too much, and if the measurement be not made till after it has become completely consolidated, he is paid to little. In cases where it would be necessary to haul for a long distance to form embankments from the road excavations, it would be more economical to allow the contractor to deposite on spoil banks as much of his cuttings as he likes, and to permit him to excavate for this purpose nearer to his work. But this indulgence should be granted only in particular instances. Wherever there is a deficiency of cutting to ballance the filling, it is proposed to make up the difference by widening the road bed, and diminishing the slopes. This may be done in almost every instance on our line, which will render the road bed more commodious and permanent, while a saving will be effected in the condemnation of lands.

Our surveys were commenced at the 18th mile stone from Baltimore, on the Washington Branch Railroad, 168 6-10 feet above tide, as a permanent point of reference. The first lines were run with a view to ascertain if the fall between the point of beginning and the head of Severn, could be equally distributed; but it soon became apparent that no such graduation could be effected without giving such a trace to our road as would destroy its usefulness, in regard to the great objects for which it is designed; and that whatever line should be finally adopted, as the definitive location, must conform measureably to the broken and waving nature of the ground. A system of undulating grades is not considered very objectionable, when, as in the present case, the trade and travel will be nearly equal both ways, and the gradients are restricted within proper limits. When the tonnage is equal in both directions, the British Engineers, so far as motive power is concerned, consider a road of undulating grades, which do not exceed 21 feet per mile, as equivalent to a level way, on the principle, that what is lost in ascending is gained in descending. This maximum of 21 feet to the mile or 1-251 has been ascertained by experiments to be the "plane of spontaneous descent," or the declivity on which a loaded car will descend under the influence of gravity alone. This declivity of spontaneous descent depends upon the amount of resistance to gravity, and this amount of resistance depends upon the perfection of the road and of the cars moving on it. Great improvements have been made, and are still making, in the principles and construction of railroad machinery. Wood, in the first edition of his treatise on railroads, states the resistance or friction at 1-200 part of the load, but in the second edition of the same work, he considered it as equal to the 1-240 part of the load. Since that time, improvements in this country, have reduced this resistance to the 1-280 part of the load, or 8 lbs. per ton. On the assumption that this is the actual amount of resistance on a well constructed road, the plane of spontaneous descent is 18.86 feet per

mile, or in round numbers, 19 feet per mile: and this corresponds very nearly with Pambour's experiments on the Liverpool and Manchester Railway. I have recently been informed, that on the new track of the Boston and Lowell road, [probably the best track in the United States,] cars have descended spontaneously a declivity of less than 9 feet per mile. If this be a correct statement, the experiment must have been made under the most favorable circumstances, and cannot therefore be regarded as establishing a principle which can be safely adopted in practice. It does, however, reduce the resistance far below any thing that had been anticipated, and speaks volumes in favor of the perfection they have attained on that road, in the construction of the roadway and cars.

In a subsequent part of this report will be found a table of gradients. I had made calculations of the power necessary to move a given weight over each of those gradients in a given time; but they have been destroyed, and I have not leisure at this time to replace them. It will be seen, however, by examining the table, that the gradients are quite moderate when compared with most railroads in this country; and as the performance of locomotive engines over different grades is well understood, in a popular form, it would be quite superfluous in me to enlarge on the subject, or to enter into any scientific analysis of their power.

It may not be inappropriate, however, to state, that recently, on the opening of the Baltimore and Susquehanna Railroad, an engine weighing nine tons, constructed under the direction of George W. Whistler, carried up an ascent of 84 feet to the mile, in addition to its tender, two passenger cars, containing 140 passengers, a distance of two miles, in seven minutes; being at the rate of nineteen miles to the hour, nearly. An engineer who was present on the occasion, writes to me as follows:--"This [the above mentioned performance] was by no means equal to the full power of the engine. Its maximum, I believe, has never been tested." We have but two grades on our road, as high as forty feet to the mile, and between 30 and 40 feet, only three grades; and these high grades are for short distances. Reference is also made to the accompanying table of curves, by which it will appear that the radii on the line vary from 1795 feet to 10,560 feet or two miles. The next shortest is 3000 feet, and more than half are at least a mile long. Very few roads present such easy curves.

These facts will enable you to form a pretty correct opinion of the facility with which your passenger trains may move with locomotive engines of moderate weight.

After all the experimental lines had been finished as far as Warfield's, and the field work plotted, it was perfectly obvious that our location must pursue nearly the crest of the dividing ridge, between the drainage into the Patuxent and Severn rivers; keeping, however, rather in the valley of the former and crossing the streams near their sources, except the two most important creeks—Chandler's or Dorsey's run and Rogue's harbor, both of which rise far up in the ridge. The former leads up towards the Patapsco, and the latter affords an easy pass to the Severn, and was contemplated as the canal route to Annapolis. It was not our object, however, to reach the Severn, but to occupy the elevated country, and thus avoid the worst ravines and ridges, all the way to Annapolis. The only streams of any consequence that we are forced to cross are Chandler's run and Rogue's harbor, as already stated. It is proposed to span the former with a wooden trestle, or pile bridge; and it would also have been recommended to pass the latter in the same way, but in arranging the grades it was found that the amount of cutting in the vicinity would be amply sufficient to make a permanent embankment, and at less cost than the expense of a wooden struc-

ture. A stone culvert will therefore be substituted to carry off the water. All the other streams, as it has been already mentioned, are crossed near their sources, and nothing more is therefore requisite than small culverts to pass off the water from springs and rain.

If our location had been carried nearer to the Patuxent, we should have been forced to adopt a far more circuitous route, with steeper grades, shorter radii of curvature, more expensive excavations and embankments, and numerous bridges and culverts. A singular feature of this country is, that the lateral ridges are higher than the main or dividing ridge, and that the laterals rise towards the Patuxent, and do not fall off till they approach the river, in consequence of which, the most level ground is generally found on the very summit of the dividing plateau.

The formation of the country naturally divides our line into three divisions, in reference to its topographical features, which of course influence the cost of construction.

1st. That portion of the line included between the Washington Branch Railroad, and the head of Severn river, in the neighborhood of Phil. Warfield's.

2d. Between Warfield's and the 15th mile, on the farm of Leonard Iglehart.

3d. Between Iglehart's and Annapolis.

FIRST DIVISION.

This division commences near the 18 mile stone from Baltimore, in the vicinity of the Savage Factory, and of the valuable granite quarries of the Patuxent. Our location unites with the Washington road on a large curve, by two curves, one turning in the direction of Baltimore, and the other towards Washington, presenting in each direction reserved curves, which will enable burden cars and passenger trains, if it should be thought advisable, to pass with undiminished velocity from one road to the other. It is not probable, however, that any advantage will be found in running the passenger trains further than the junction of the two roads; and the location has been so adjusted, that the trains may be brought along side the Washington branch, and the passengers transferred from one train to the other without inconvenience. The curvatures and grades on our line being so moderate, there need be no difficulty in running the trains in time for the Baltimore and Washington trains, and by a judicious arrangement between the two companies, there ought not to be any detention, at the depot, of the passengers travelling on your line in either direction, as your road intersects the Washington road at a point equi-distant, *in time*, from Baltimore and Washington; and the interests of both companies would be consulted by establishing a depot, for mutual use, at the point of junction.

Leaving the Washington branch road, our line follows the general direction of the Patuxent valley, and crosses Chandler's run in the first mile, which stream, as has been already stated, it is proposed to pass with a trestle bridge. This species of bridge is recommended for its cheapness and not for its intrinsic merit, as it is the most common and least durable that could be adopted. It is liable to rapid decay, and repairs would be difficult and expensive. If the resources of the company would justify the expense, I would urge in the strongest manner to substitute Col. Long's plan of wooden bridge with stone piers, of 100 feet span, or some other kind of truss bridge; and of greater span, if it should be thought proper to diminish the number of piers by increasing the extent of the span. It is proposed in all cases to cover the timbers with tar to protect them from the weather, and to

saturate them with a solution of corrosive sublimate, to preserve them from the dry rot.

After crossing Chandler's run the line occupies highly favorable ground to the end of the third mile, where rock is for the first time encountered.—It shows itself in a very narrow ridge which appears to be the outcrop of a conglomerate of pebbles united by a ferruginous cement, forming the substratum of the country. On the fourth mile we cross both branches of Rogue's Harbor, which will require two culverts and a heavy embankment. This brings the line near a school house on the county road in the vicinity of Disney's and Miller's. On the fifth mile we pass Miller's house and cross another branch of Rogue's Harbor, and the county road. As the embankment is high and a culvert is required to pass the water, it will be proper to make it sufficiently high to span the road also. The sixth mile passes near to Watts' Tavern, where a deep cut must be made through a narrow sand ridge. Here for the first time we strike upon the drainage of the Severn, having crossed the dividing ridge between it and the Patuxent, which is here very narrow, the streams in fact interlocking, and our line occupying very nearly its crest. The seventh mile carries us past Sappington's to the deep cut, which lies principally in the next mile. It is not improbable that this cut may develope the presence of rock, although there is none to be seen near the surface, and if such should be the case the grade may be increased in order to diminish the amount of excavation, and of course the slopes would also be reduced and approach nearly to the vertical. The eighth mile, as has been already observed, passes through a deep cut, the heaviest work on this division. The greatest depth of cutting is twenty feet, and the amount of excavation 46000 cubic yards. The ninth mile passes through the farm and near the house of Rezin Hammond, and crosses Jay's branch, a tributary to the Severn. Some rock excavation may be expected on this section, but not more than will be wanted for the culverts over Jays' branch. Five eighths of the next mile completes the first division, extending 9 5-8 miles, and ending on Dorsey's farm. The total cost of graduation and masonry on this portion of the work is estimated at $75,812,33. Some changes might be made, with a view to economy, both in grades and trace; but those alterations would lessen the efficiency of the roads, and although indicated on the profile and map, they are not recommended for adoption.

SECOND DIVISION.

This division commences at 9 5-8 miles from the Washington branch. The first section of this division is very heavy, giving a total of 98,645 cubic yards of excavation, and 131,808 cubic yards of embankment. The average haul for the greatest embankment will be but little short of half a mile. The other hauls will be short. In the cutting of the second ridge on the first half mile, it is possible that rock may be encountered; but this opinion is based on the peculiar shape of the hill, and not on the actual appearance of stone. The nature of the country, below this locality in our line, forbids the idea of finding rock in our excavations. The ground is much cut up by deep ravines, as the profiles show, and no stone has been found in any of those ravines. The length of this heavy section is 2 1-4 miles and it terminates near the Primary school house, in the vicinity of the Sun Tavern and Post Office. This is, with one exception, the most expensive section on the whole line: it will be seen that the embankment exceeds the excavation by 36,000 cubic yards; but this will enable us to improve the bed of the road-way, on the high grade of 40 feet to the mile, by widening it and increasing the size of the ditches to carry off the water

with facility, and thus to preserve the road bed from injury by washing.—I fear the nature of the ground is such as will lead to difficulties on this division in very rainy seasons, in preserving the slopes of the cuts and embankments, and the road-way from injury. Great care must be taken with this portion of the work, and the slopes [in relation to the horizontal] should be as small as possible. The ditches should be wide and shallow, else I fear they will gulley very soon. If the ditches were well paved with, and the sleepers well bedded in, beton, it would probably prevent any of those bad consequences. The earth over the whole of this division is easily removed; but the cost of repairs, for one or two years after its completion, will probably be considerable. The next section, one mile long is very easy. The ravines on this division are crossed near their heads, which renders but few culverts necessary. I propose to throw in stone, if it can be found conveniently, at the base of the embankments, forming something like French drains, to enable the water to percolate through; this, I think, will be amply sufficient in most cases where there are no springs. The areas of the ravines above the embankment are generally small, and no great quantity of rain can ever fall in them, and the water from the higher ground may be prevented from flowing into them by ditches which will convey it off under the road bed.

The next section is, for its length, the most expensive on the whole line. But it is believed that a change may be made on this part of the location to great advantage, by which the expense will be considerably diminished without injury to the efficiency of the road. The proposed alteration is indicated on the map; but it would be advisable before these suggestions are adopted, or the contracts let, to revise carefully this portion of the line.—On this section there are 115,200 cubic yards of embankment and 112,000 cubic yards of excavation. The difference may be taken as heretofore recommended, from the road bed, but a good deal of the cutting cannot be used for the filling, as the hauling would be too long to render it advisable to use it for that purpose. The length of this section is 2 1-8 miles.

The ravines on the first section of the 2d division drain into South river, but the dividing ridge between South Severn Rivers is very narrow, in some places not more than two rods wide, and our line is compelled to conform very nearly to the crest of this ridge, or otherwise encounter the deep and broad gulfs which are formed by the washing of the rains. A peculiarity of these ravines is that they become very deep, varying from 75 to 100 feet in depth, in a short distance from their heads.

This division terminates a short distance beyond the 15th mile, directly opposite to Leonard Iglehart's house. It is nearly 5 1-4 miles long, and is estimated to cost $120,737.

THE THIRD DIVISION:

Commences near Iglehart's, and terminates on the lot of Mr. Brewer, near a blacksmith's shop, on the upper part of West street, in Annapolis. The line was continued down Gloucester street, to the mouth of the Spa creek, near the residence of the late Charles Carroll. Vessels drawing eleven feet water, may pass the bar on this creek. The line curves through the church grounds close to the building. This is of course objectionable, and can only be avoided by adopting some other termination, if it be deemed advisable to continue the road to tide-water. There are several points at which the road may terminate with nearly equal advantage to business and convenience of passengers. But I have thought it best not to submit any estimate, for the continuation of the road beyond Mr. Brewer's lot, which furnishes a good position for a company depot and machine

shop. But, before the contracts are let, it will be necessary for the Board to fix the terminus of the road, as the location of the depot must depend on that decision.

A line was also run from the neighborhood of the three mile oak, to Spa creek, in the vicinity of Mr. James Murray's. This route and the profile of the ground are given. The Board will be able to decide if this line be a judicious one or not. As this is a question involving the local interests of Annapolis, and the injury to private property in the vicinity, it would be improper for me to offer any opinion on the subject; more especially as the Directors are far more competent than myself to decide such matters.

The two routes, so far as the engineer may regard them, are nearly equal; but the termination of a public improvement is generally dependant on other considerations.

The extra filling in the vicinity of the negro hut on Dorsey's farm will enable us to widen our road bed. It was at one time contemplated to bridge over College creek, but it appears that the cutting in the neighborhood will be sufficient to form a permanent embankment, with a culvert over the stream, to pass the water, without any additional cost. By carrying the line a little more towards College creek, there would be less injury done to Judge Brewer's orchard, and the quantity of work at the same time would be slightly diminished.

The greater portion of this division is decidedly favorable, and the approach to Annapolis peculiarly fine.

There is but a single change on this division suggested, and that is an additional curve, of at least one mile radius, near Nicholas' on Robert Welch's farm. It would have the effect of shortening our line, avoiding the public road, and obtaining rather more favorable ground. The length of this division is 4 5-8 miles, making the whole road 19 3-4 miles in length. It is estimated that the graduation and masonry on this division will cost $37,116 33.

On a careful review of the whole line, I feel myself authorised in congratulating the friends of this project on the favorable character of the location, and the advantages its completion is calculated to confer upon the city of Annapolis, and the State of Maryland.

RECAPITULATION.

Cost of Graduation and Masonry.

1st. Division,	$75,812 33
2d. Division,	120,737 52
3d. Division,	37,116 33
Total,	233,666 18
Superstructure, bar rail,	70,000 00
	302,666 18
For contingencies, superintendence, &c. 10 per cent,	30,366 79
Total,	334,032 97
For an edge rail, of 30 lbs. to the yard:	
For graduation and masonry, as above,	$233,666 18
Superstructure,	96,400 00
	330,066 18
Add 10 per cent, as above,	33,006 61
Total,	363,072 79

(To be continued.)

SPECIFICATION OF A PATENT FOR IMPARTING TO ARTICLES OF IRON AND STEEL AN INCREASE OF STRENGTH. GRANTED TO WALTER R. JOHNSON, CITY OF PHILADELPHIA, JUNE 30, 1838. ANTEDATED DECEMBER 30, 1837.

To all to whom these presents shall come: Be it known, that I, Walter R. Johnson, of the city of Philadelphia, in the state of Pennsylvania, have invented a new and useful improvement in the manufacture of wrought or malleable iron and steel, and of articles formed thereof; being the imparting to said materials of an increase of strength, by means of a process which I call thermo-tension, and that the following is a full and exact description of carrying into effect my said improvement.

The said process is founded on the principle that the strength of said materials is increased by means of mechanical stretching, or straining, at a high temperature.

I perform the said process in the following manner: I first determine in the usual manner, by trial and calculation, what strain might, at the ordinary temperature of the air, and before my improvement has been applied to it, be sufficient to break the particular piece of metal, or manufactured article, intended to be improved by the process of thermo-tension.

I then, by means of any suitable apparatus for applying heat and measuring temperature, subject the piece or article to be strengthened, to a temperature not exceeding seven hundred degrees Fahrenheit, preferring that of five hundred and fifty degrees for most kinds of iron, not restricting myself, however, to the same temperature for all kinds of iron and steel, but varying to a higher or lower temperature, according as the same shall be found most serviceable for the particular kind which is undergoing the process.

When the proper temperature has been attained, I apply, by means of any suitable apparatus for applying and measuring mechanical strain, a force equal, or nearly so, to the calculated strength of the specimen or article under process, and continue to apply the same as long as the metal continues to be stretched by it.

I contemplate the application of the improvement and process above described, herein called the process of thermo-tension, to the metals, wrought or malleable iron and steel of whatever form in which an increase of direct cohesion may be found useful, whether the same have been manufactured by rolling, hammering, drawing, or by any other process, as I do not confine my improvement to any particular form of materials, or of articles manufactured therefrom.

What I claim as my improvement in the art of manufacturing iron and steel, and of articles formed therefrom, is the submitting of them, while at high temperature, to mechanical stretching, or straining, as above specified, for the useful purpose of increasing their direct cohesion, by whatever means the necessary force shall be applied, and measured, or the requisite temperature communicated and regulated.

WALTER R. JOHNSON.

TREMENDOUS POWER.—A locomotive engine built at Lowell, for the Western Railroad, on Thursday, started from a state of rest a train of sixty-three cars, filled with merchandise, weighing *three hundred and thirty-three tons*, of 2000 lbs., and carried it with ease over an ascent of 10 feet to the mile at the rate of nine miles an hour!